THE

AMERICAN JOURNAL

OF THE MEDICAL SCIENCES.

OCTOBER, 1887.

CONTUSION OF THE ABDOMEN, WITH RUPTURE OF THE INTESTINE.

BEING THE ESSENTIAL PART OF AN ESSAY AWARDED THE CARTWRIGHT PRIZE OF THE ALUMNI ASSOCIATION OF THE COLLEGE OF PHYSICIANS AND SURGEONS, OF NEW YORK.[1]

BY B. FARQUHAR CURTIS, M.D.,
ASSISTANT SURGEON TO THE NEW YORK CANCER HOSPITAL.

THE operative treatment of traumatic peritonitis, and of the injuries which cause it, is a matter of such universal interest at present that these pages need no apology. By a series of 44 experiments upon dogs, the general subject of contusion of the abdomen with rupture of the intestine has been studied. By experiments upon the cadaver it has been sought to throw some light upon the still doubtful mechanics of rupture of the gut. An analysis of 116 cases of rupture of the intestine, and of 33 cases of contusion of the abdomen terminating in recovery, has been made, with especial attention to the symptoms of the first hours after the injury, in the hope of rendering an early diagnosis possible. Finally, an attempt has been made, in the light of the experimental and clinical experience thus far gained, to indicate the most promising methods of treatment.

I. EXPERIMENTS UPON DOGS.

The experiments on dogs were conducted upon the following plan:[2] The animals were put under the influence of ether, laid upon the back on the floor, and a weight dropped upon the abdomen. The weights varied from six to twenty-one pounds; and the height of the fall from four to seven feet. The striking surfaces employed were as follows:

---

[1] The original essay, containing a full account of all the experiments, and tables, with an analysis of the cases, and references to their source, has been deposited in the library of the New York Academy of Medicine.

[2] The experiments were performed at the Carnegie Laboratory in New York, and the author is indebted to Dr. G. B. Phelps and Dr. F. A. Manning for most valuable assistance in the operations.

Surface A. The side of a cylinder fifteen inches long, and one and a half inches in diameter, the cylinder being dropped in a horizontal position, its long axis crossing the animal's spine at right angles.

Surface B. A convex, circular surface, about two and a half inches in diameter, the greatest height of the convexity being about half an inch. For most of these experiments, a common porcelain door-knob formed the striking surface.

Surface C. A rectangular piece of wood, five by two inches, the edges rounded off, leaving a flat surface in the middle, three by one inches. This was also dropped with its long axis crossing the spine at right angles.

After the blow had been inflicted, three courses were pursued. 1. The animal was allowed to recover from the ether and left to its fate. 2. Laparotomy was performed after an interval of twenty-four hours; or of only five hours. 3. Laparotomy was done at once—the most usual course.

The immediate symptoms produced by the blow were trifling. Shock appeared in about one-half the cases, but it was usually slight. It was present in three of the cases in which no injury was sustained, and was severe in one of these, so that it was no indication of the severity of the injury received. When severe, it was generally a sign of great hemorrhage, or was due to the fact that the animal was not entirely under the influence of the ether.

In ten cases no injury was produced—in three of these nothing further was done, the intention being to wait for symptoms; in the others laparotomy was performed at once for exploration.

In the dog the cæcum lies by the side of the last part of the ileum, deriving its blood supply from a branch of the mesenteric artery which runs in the cellular tissue between the two. In two cases the cæcum was separated from this attachment to the ileum, rupturing the branches of this vessel, the main trunk being left attached to the small intestine. This artery was of such large size that in one of these cases four ounces of blood were lost from it in the few minutes elapsing before the belly was opened. In both cases gangrene of the cæcum was inevitable, and that part was resected, both animals recovering.

Laceration of the mesentery, so severe as to deprive part of the intestine of its blood supply, occurred in thirteen cases, and was treated by immediate laparotomy, except in one case which died of hemorrhage half an hour after the injury. Four others died on the table of hemorrhage. An artificial anus was made three times and the intestine resected five times—but all died within twelve hours of hemorrhage and shock, except one of the resection cases, which lived for forty-eight hours, dying of peritonitis from silk which was not aseptic. The unfortunate results of the cases of artificial anus led to frequent attempts at resection, although the animal was too feeble to warrant it, and death was caused by the shock and exhaustion due to the prolonged operation.

In addition to these cases of laceration of the mesentery necessitating resection, there was one case in which a large branch of the mesenteric artery was injured, with such a profuse hemorrhage that life was endangered. The vessel was secured by ligature, the collateral circulation of the corresponding part of the gut found sufficient, and the animal made a good recovery.

Contusion of the intestine severe enough to require treatment occurred in ten cases, including those cases in which the ecchymosis was so extensive as to threaten perforation of the gut, most of them being also accompanied by a laceration of some of the coats of the intestine. The usual form of this last injury was a small fissure in the peritoneal and muscular coats exposing the fibrous coat. It must be remembered that in the dog the submucous coat of the intestine is developed into a strong fibrous tissue resembling a thin aponeurosis, making the wall of the gut very much stronger than in man. Even if the fissure was small, the edges were so bruised and ragged that the fibrous coat, although itself uninjured, was deprived of all blood supply, except the minute vessels which lay in its own tissue, between it and the mucous membrane, or in the tissue of the latter. In injuries of this kind the mucous membrane was found entirely destroyed by the blow, or separated from the underlying fibrous coat by effusion of blood, so that there was no possibility of its capillaries supplying the latter with blood even if they are normally equal to the task—which seems doubtful.

In four cases the injured point was turned into the lumen of the gut and sutured, and three of these recovered, the fourth dying of intestinal obstruction, caused by a Z-shaped bend in the gut at the point of suture, held by firm adhesions. Six cases were treated by resection, of which two recovered. The others died—one of shock, two by yielding of the sutures at the point of resection, and one of peritonitis caused by silk which was not aseptic. Thus we have in this set of cases a total of five recoveries and five deaths.

One of the later experiments illustrated the necessity for these precautions in a very striking way.

In this case (a dog which had been already subjected to a resection experiment) the weight was dropped and laparotomy was performed five hours later. The intestine was found ruptured entirely across at a point in the duodenum, and a loop which had been adherent to the inner surface of the former abdominal wound had been forcibly separated from its adhesions, thus tearing off its peritoneal and the greater part of its muscular coat for a space of about one inch square, but not laying the fibrous coat entirely bare. The dog was so feeble by the time that the ruptured point had been sutured, that it was determined to leave this doubtful place to nature—the rather because there had been no contusion at this point, the injury having been caused by a dragging and stripping off of the superficial parts, and there seemed good reason to suppose that the mucous membrane was intact, and that its vessels would suffice to supply the fibrous coat with blood. The dog died of shock about eight hours after the operation, and we found that the doubtful spot was black and completely gangrenous.

Rupture of the intestine was produced in eight cases, in two of which there were two ruptures. Of these ten ruptures of the gut, four extended completely across it, and two almost across. Of the rest, three were directed in the long axis of the gut, while only one was transverse—all four being situated on the free border. One of the two cases which extended almost across the gut involved all but the attached border, the other all but the free border—the latter a very rare form of the injury.

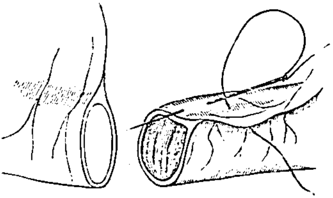
The mucous membrane was generally everted, but not in all cases—depending upon the amount of contusion which the edges of the opening had suffered. In some cases, in which laparotomy was done at once, the edges were found much less everted at first than they subsequently became, for the muscular contraction which causes the eversion occurs slowly, and the muscular tissue may have been partially paralyzed by the blow. This gives another proof of how little eversion of the mucous membrane is to be depended upon to prevent fecal extravasation. In the complete ruptures the ends were partly closed by muscular contraction. The same contraction caused wide gaping of the ruptures which were directed in the long axis of the gut.

Rupture of the intestine was treated in one case by resection with suture of the gut five hours after the injury. The dog died of shock and beginning septicæmia and peritonitis, within twelve hours. It was treated by immediate laparotomy in four cases. One of these died from hemorrhage within one hour after the injury, there being a laceration of the mesentery also. Two were too severely injured to permit resection and suture, and an artificial anus was made. One of these died of shock; the other recovered from the operation but succumbed to purulent peritonitis starting from the abdominal wound. The remaining case had a rupture which admitted of suture, as it did not extend entirely across the gut, and recovered.

The most troublesome part of suture of the intestine in resection is the introduction of the stitches at the mesenteric border, on account of the difficulty of bringing the serous surfaces in contact at this point. The triangular interval between the two layers of the mesentery at its attachment to the gut cannot be much reduced by the lateral pressure of two Lembert sutures, placed one on each side of the mesentery in the usual way. A small raw surface, the cut edge of the mesentery, will always remain, communicating at one end with the interior of the gut, and at the other with the peritoneal cavity. It occurred to me that if the mesentery could be folded down upon the outside of the intestine, and then turned in with the latter at the point of suture, this raw surface would be reduced to a minimum.

To secure this by sutures, they should be passed in the following manner: Let the cut end of intestine nearest the operator's right hand hang free from its mesentery. Pass the needle through the mesentery at a point one-third of an inch from the free edge of the mesentery and one-quarter of an inch from its attachment to the gut. Taking up the needle on the further side of the mesentery, make a Lembert stitch on the surface of the intestine on that side, entering the needle one-third of an inch from the cut edge of the gut and one-quarter of an inch from the attachment of the mesentery to the gut, and keeping it parallel with the mesenteric attachment, bring it out near the cut edge of the gut in the ordinary way (Fig. 1). Then pass the needle back again through the mesentery at a point one-quarter of an inch from its attachment to the intestine, but near its cut edge, so that the needle will finish upon the same side of the mesentery as it started from. If the thread is now drawn tight, it will be seen that the mesentery is folded down upon the side of the gut by the thread.

FIG. 1.

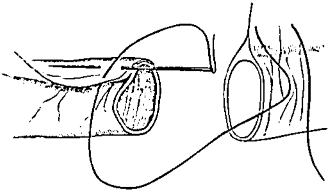


Now hold up the other end of intestine by its mesentery, the edge directed toward the first, as it is intended to unite them. Pass the needle through the mesentery of this second end of gut near its cut edge and one-quarter of an inch from its attachment to the intestine. Taking up the needle on the further side of the mesentery, make a Lembert stitch on the surface of the intestine on that side, entering the needle near the cut edge of gut at a point one-quarter of an inch from the attachment of the mesentery, and bringing it out one-third of an inch from the cut edge of the gut and one-quarter of an inch from the mesenteric attachment (Fig. 2). The needle is then to be passed back again through the mesentery at a point one-quarter of an inch from its attachment to the intestine and one-third of an inch from its cut edge (Fig. 3).

The completed stitch is exactly the same on both ends of the gut, although the course of the needle on the second end was just the reverse of that taken on the first.

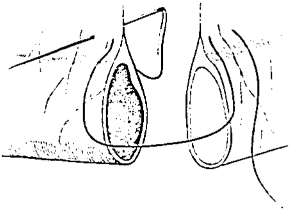
It will then be seen that the two Lembert sutures are on the same (further) side of the mesentery, and parallel to its attachment to the intestine. If the ends of the thread are drawn upon, it will be found that the mesentery of both ends of the gut is folded down upon the sides of the intestine. If they are drawn still tighter, the ends of the gut will be turned in (in the usual way with the Lembert suture), and carry the edges of the down-folded mesentery with them, and a knot can be made in the ordinary manner.

FIG. 2.



We have thus succeeded in disposing of the thickest part of the mesentery by turning it into the lumen of the intestine, just as the raw edges of the gut itself are turned in. At a distance of one-quarter of an inch from the mesenteric attachment the loose cellular tissue which fills the triangular space between the layers of the mesentery close to the gut is much reduced in quantity, if not altogether absent; and when the mesentery has been turned down upon the side of the intestine as described above, this thin part of the mesentery is the part which will

FIG. 3.



find its way out of the seam when the ends of the gut are turned in. This is far less likely to interfere with prompt union than the comparatively broad surfaces brought together by the sutures as usually applied. This stitch is much more complicated in its description than in its application, although it cannot be denied that the latter is also difficult. But the much greater security which it affords has proven it to be well worth the additional trouble in the numerous cases in which it has been used.

Having applied this stitch, two Lembert sutures should be inserted close to it, one on each side. One of these has to pass through the place where the mesentery is folded over, making several thicknesses with considerable cellular tissue, and the needle must be made to pass a little deeper than usual in order to take up the muscular coat, otherwise it will tear out very easily.

The following conclusions are justified by the facts already presented:

1. Exploratory laparotomy can be performed without danger.
2. The most common causes of death after contusion of the abdomen, produced as described, are hemorrhage and shock; and the latter is greatly increased by a prolonged operation, such as resection of the intestine.
3. Some cases of internal hemorrhage, otherwise fatal, can be saved by prompt action.
4. Prompt action will save life in contusion, threatened gangrene, and even rupture of the intestine.
5. The danger is greatly increased by delay, as shown by the early occurrence of gangrene, the rapid failure and death of cases left without treatment, and the greatly impaired strength found in cases in which treatment was delayed.

II. Experiments upon the Cadaver.

There are two theories in regard to the mechanical causation of rupture of the intestine by contusion of the abdomen—that it is caused by a blow inflicted upon the gut distended with gas or with fluid contents; and that it is caused by the crushing of the gut, whether distended or empty, between the contusing body and some hard background, usually the spinal column. Longuet[1] dropped a weight upon the bodies of three cadavers, alternately over the spine and to one side of it. In order to gain additional evidence, I have repeated his experiments upon four cadavers.[2]

Including both series of experiments, we obtain a total of five blows delivered in the middle line, causing in three a rupture of the gut, and in the other two a laceration of the mesentery. On the other hand, of nine blows delivered laterally, in six cases there was no injury; and in the three in which injury was caused, the weight touched the side of the spine in its fall, but in none of these three was a rupture of the gut produced. Thus, in a total of fourteen blows, the eight which struck the spine produced injuries, and the six which did not touch it were harmless.

---

[1] Bull. Soc. Anat., Paris, 1875, l. p. 799.

[2] The author is indebted to Dr. George L. Peabody, Pathologist to the New York Hospital, for the opportunity to experiment upon the cadaver.

This evidence proves conclusively that distention of the intestine is not necessary for rupture, but that a contact between the contusing body and some solid resistance, such as would be furnished by the spine or the pelvic bones, is indispensable to produce rupture in the empty gut. But there is still some footing left for the old theory. Can a distended loop of gut be ruptured when it lies upon one side of the spine, where we have proven the collapsed gut to be safe from injury? To determine this point, the following experiments were performed:

An incision about three inches long was made in the middle line of the belly, the lower end of the incision being placed at the pubes. One or more loops of gut were drawn out, inflated with air after isolation between two ligatures, returned to the belly, and placed either over the spine above the incision or upon one side of it, in the lumbar region. The incision was closed by suture, and the weight dropped directly over the prepared loops. This experiment was carried out upon five cadavers.

In this set of experiments, of four blows delivered upon loops lying in the middle line, in front of the vertebræ, rupture of the gut was produced twice, and rupture of its peritoneal coat in the other two cases, in one of which there was also produced a laceration of the mesentery. This last experiment shows how readily the inflated gut may escape rupture, for the descending weight could only have reached the mesentery by pushing aside the intestine, which lay in front of it. One of these experiments shows that the inflated gut may even prevent injury to other structures, for it is the only experiment of all performed by Longuet and myself in which a direct blow upon the spine failed to produce some injury, for rupture of the peritoneal coat can scarcely be considered an injury. We must, therefore, acknowledge that inflation of the gut does not increase the danger of rupture in loops lying against the spine, and may even diminish it.

On the other hand, of seven blows delivered upon loops placed at the side of the spine, in only three was no injury produced, while rupture of the gut occurred three times, and rupture of its peritoneal coat once.

We may conclude that—

1. In contusion of the abdomen the intestine is ruptured by being crushed between the contusing body and the bony parts—the vertebræ and pelvis. This injury is therefore not a true *rupture*, but a *contused and lacerated wound* of the gut.

2. Partial distention of the gut, especially if a large part of the intestine is distended, diminishes the danger of rupture. If great distention of an isolated loop ever occurred in life, it would increase the danger of rupture, even for a loop not in contact with bony parts.

3. The most exposed position for the gut is in contact with the bony parts—in front of the vertebræ, near the brim of the pelvis (when hernia is present), and near the crest of the ilium.

4. There are many chances in favor of escape of the intestine from injury in contusion of the abdomen—there may be no gut lying directly at the point where the blow is inflicted; the gut may be partially inflated with gas; or it may slip away from the pressure exercised by the blow. This fact is of great importance in its bearing upon the question of early performance of laparotomy for rupture of the intestine.

III. Clinical.

Pathology.—116 cases of rupture of the intestine have been collected with the intention of studying the symptoms of the first six to twelve hours after the accident, only those cases in which these symptoms were described with sufficient fulness being accepted. A few exceptions were made to this rule in order to secure examples of rare symptoms, or of rare forms of injury, and thus the proportion of these unusual cases is greater than would be found in a consecutive series of cases, and due allowance must be made for this fact in certain points which will be hereafter pointed out.

The cause of the injury is described in 99 cases. The most common cause is the kick of a horse or man, numbering together 28 cases—twice as many as are due to any other cause. Next to this, and all nearly equal in the number of cases, are the run-over accidents (13 cases), the blows on the belly by heavy weights (16) and by light weights (13), and the falls upon projecting points (13). The so-called "buffer accidents" are comparatively rare (4 cases). It is evident that the great velocity and small area of striking surfaces are the elements which make a kick so dangerous.

The relative frequency of injury in different parts of the intestine is shown by the following: in 113 cases, the duodenum was injured 6 times, the jejunum 44, the ileum 38, other portions of the small intestine 21 times, and the large intestine only 4 times. This proportion indicates that the liability of the jejunum to injury is no greater than that of the ileum. The duodenum escapes on account of its sheltered position. In 43 cases the exact site of the rupture is given in the jejunum and ileum, and in 25 (58 per cent.) of these it lay in the first three feet of the jejunum, or in the last three feet of the ileum. In 12 cases (28 per cent.) the rupture was situated in the first eighteen inches of the jejunum, and in 6 (14 per cent.) in the last eighteen inches of the ileum. These facts bear out the old theory that the danger of rupture is greatest in those parts of the intestine which are most fixed in their position in the abdomen, but the large intestine must be excepted on account of its sheltered position.

Of the entire 116 cases the rupture extended completely across the intestine in 20 cases, and almost across in 4. In 11 cases there were multiple ruptures, in 2 of these there were four ruptures, in 2 there were three, and in 3 two. In only two of the cases in which the rupture extended part-way across the intestine is it mentioned that the mesenteric border alone was involved. In only one case[1] was the rupture so situated as not to communicate with the peritoneal cavity, and then it lay on the posterior wall of the duodenum where it passes behind the mesentery.

The rupture varies from the size of a quill to one which will admit four fingers, but is most frequently about one inch in diameter. Is there any constant relation between the force of the blow and the extent of the rupture? A study of the twenty cases in which the rupture was complete, shows that the blow was severe in all but two. On the other hand, among the causes of the twenty-two cases in which the rupture was half an inch or less in extent, there are only three in which the blow appears to have been severe. These cases warrant the assertion that the amount of injury will be proportional to the violence of the blow, but that exceptions will not be infrequent. A small rupture, however, is almost as certain to prove fatal as a large one, so the question has very little practical importance. A striking instance of this is a case[2] in which the rupture was only one-third of an inch in diameter and yet death occurred in sixteen hours.

Eversion of the mucous membrane at the injured point is the rule, being mentioned as present in ten partial, and four complete ruptures, while it is noted as absent in only two cases. Jukes also records a case[3] in which there was an extensive lesion of the peritoneal coat, with a rupture of the bowel the size of a goose-quill, with no eversion of the mucous membrane—fecal extravasation and peritonitis were present and death had occurred forty hours after the accident. In one of our cases[4] the mucous membrane rolled out and the peritoneum turned in, the two covering the cut edge of the muscular coat.

Fecal extravasation is almost invariably present, but may be delayed, or even absent. It is recorded as present in seventy-three cases, but the presence of peritonitis in nearly all the rest makes it probable that it was present in them also, although peritonitis may possibly arise from other causes than fecal extravasation. In nine cases it is recorded as absent. In some of these cases peritonitis was present, but they show that it is not impossible for fecal extravasation to be wanting. In two cases[1] of complete rupture, the open ends were so entirely closed by muscular contraction, prolapse of the mucous membrane, and rapidly formed adhesions, that the bowel was actually found to be distended above the injured point. In such a case it is easy to understand how fecal extravasation could be prevented—and, in fact, in one of these cases the onset of symptoms was delayed. This condition would be more likely to occur with complete ruptures than with partial—unless the latter were very small, just as hemorrhage is more severe when an artery is wounded in part of its circumference than when it has been entirely divided and the injured end is free to contract and retract. The phenomena observed in the experiments upon dogs as to the contraction of the intestinal muscle furnish excellent illustrations of this subject.

---

[1] Gärtner: Vierteljahrschrift f. prakt. Heilk., Prag, 1854, xlii p. 44.

[2] Annan: American Journal of the Medical Sciences, xxi. p. 530, 1837.

[3] Jukes: Med. Chir. Journ. and Rev., v. p. 209, 1818.

[4] Chavignez: Bull. Soc. Anat., Paris, 1839, xiv. p. 217.

With rupture of the intestine were found in twelve cases contusions and other slight injuries of the gut. Contusion of the gut may lead to peritonitis even when not so severe as to cause gangrene and perforation, as has also been shown by Grawitz,[2] the diminished vitality of the tissues allowing microörganisms to penetrate them and set up inflammation in the adjacent peritoneum. Similar conditions are seen in practice, in the peritonitis accompanying intestinal obstruction, or following the reduction of a strangulated hernia.

The most frequent and important complication of rupture of the intestine is laceration or contusion of the mesentery. The hemorrhage from the ruptured gut is trifling unless the mesenteric border is involved, and even then it is not usually serious. But hemorrhage from laceration of the mesentery may cause death in a few minutes, and even slight injury to its vessels may deprive part of the intestine of its blood-supply, and cause gangrene, although the gut itself have escaped injury. There are four cases of contusion, and fifteen of laceration of the mesentery, complicating the cases of rupture of the intestine. Of the last set of cases all but three of the patients died within twenty-four hours, and in these three no mention is made as to the state of the circulation in the gut at the time of death. In some of those in which death occurred early, gangrene of portions of the gut was inevitable; and in a case in which laceration of the mesentery was the only injury, it was found that gangrene had already taken place at the time of death. The frequency and gravity of this complication of rupture of the intestine does not seem to be properly appreciated. It occurred in sixteen per cent. of the cases collected, and we have already seen how often it was produced in the experiments on dogs. Probably the smaller lacerations (competent, however, to produce gangrene) are frequently overlooked in the autopsies made in cases of contusion of the abdomen dying in the first twenty-four hours, and many such cases with symptoms of severe internal hemorrhage are allowed to pass without autopsy on a diagnosis of rupture of the liver or spleen, in which the real lesion is a laceration of the mesenteric vessels, with or without injury to the intestine.

---

[1] Partridge: Trans. Path. Soc., London, 1860–1, xii. p. 109. Poland: Med. Times and Gaz., ii. p. 445, 1868.

[2] Charité-Annalen, xi. Jahrg., p 770, Berlin.

SYMPTOMS OF THE EARLY STAGE.—The symptoms immediately following the injury are of the greatest importance, for the diagnosis must be made as soon as possible, if the treatment is to be successful.

These symptoms are shock, with or without loss of consciousness, restlessness, vomiting, retention of urine, absence of fecal passages, local pain and tenderness, and the physical signs afforded by examination of the abdomen. The condition of the pulse at this time will not need separate consideration, as it depends upon the amount of shock, and hemorrhage, and often does not assist even in a distinction between these. The temperature is of little value as a guide, although it is sometimes subnormal when the shock is great, and may rise as peritonitis develops.

The symptoms may all appear immediately upon receipt of the injury, or one or all may be delayed for some hours. Delay in the appearance of symptoms was present in ten cases, and some are so remarkable as to deserve a fuller account.

A boy,[1] thirteen years old, received a blow upon the abdomen from the pole of a churning machine, walked a mile with but little assistance, had great pain and vomited frequently and persistently, but the symptoms were "not at all marked." In twelve hours sudden collapse came on, and death followed one hour later. Autopsy showed a complete rupture of the duodenum.

A man,[2] nineteen years old, fell from his cart while drunk, and the wheel passed over his body. He was insensible from drink, and vomited the contents of his stomach, but there was no shock and no other symptoms. The next day he felt well, there was no tenderness in the abdomen, and the urine and stool were passed normally. He was allowed to walk about the ward of the hospital, and to eat three meals of bread, broth, and milk. Twenty-six hours after the accident, and half an hour after the last meal, sudden cramping pains in the abdomen came on, collapse followed, and death in one hour and a half. Autopsy showed a complete rupture of the jejunum.

A strumous girl,[3] eleven years old, in running up stairs, fell and struck her abdomen, at the level of the umbilicus, on the edge of a step. She cried a little, but walked up stairs, then vomited the contents of her stomach, fell asleep and slept half an hour. She seemed a little faint, and was kept in bed, but she felt well and had no pain. She slept well all that night. Twenty hours after the accident she walked down stairs, after which she felt slight pain in the abdomen for awhile, and there was some tenderness. Four hours later she ate a few mouthfuls of egg-pudding, the first food she had taken since the accident, vomited it, fell into collapse, and died at once. Autopsy showed a rupture of the jejunum extending for half of its circumference (the edges bruised, the mucous membrane appearing as if it had not been everted), fecal extravasation, and beginning peritonitis.

---

[1] London Medical Gazette, 1833, xii. p. 766.

[2] Walker: Lancet, 1881, ii. p. 637.

[3] Holland: British Medical Journal, 1873, i. p. 703.

The proportion of these cases to the entire number in the table is misleading, for such peculiar cases are much more likely to secure publication than those which run the ordinary course. The true proportion must be far less than one in eleven.

Shock. In 95 of the cases the presence or absence of shock is noted. Shock was present in 76 cases—80 per cent.; and absent in 19 cases—20 per cent. It is described as severe in 30 cases, and as slight in 16 cases.

Consciousness. Consciousness was retained at the time of the accident in 54 cases, was almost lost in 4 cases, and was lost in 11 cases. But four of the cases in which it was lost lived two, four, and seven days, and the symptom is altogether unreliable as an indication of the severity of the injury, and even of the degree of shock present.

Restlessness. Restlessness is not a common symptom. It is noted as present in the early stage in eight cases; while it appeared in one case after six hours, in one case after twelve hours, and in two cases on the third day. The last two cases do not properly belong here, but they are quoted to show that restlessness is not exclusively a symptom of internal hemorrhage. In these cases it is doubtless to be regarded as due to the peritonitis—perhaps merely as an unusual symptom of the accompanying fever. In two of the cases there was no hemorrhage, and in two it was slight, and yet this symptom was present from the first. In these cases restlessness must be regarded as part of the symptom-complex of shock.

Vomiting. Data as to this symptom in the early stage are given in 90 cases. Vomiting was present in 72 cases—80 per cent.; and absent in 18 cases—20 per cent. There was nausea in four of the cases in which there was no vomiting, and in most of them vomiting appeared as a symptom of the later stages. The vomiting was severe in one-third of the cases in which its presence was noted, and it is described as slight in only five cases. The vomiting may be continuous, or occur at long intervals, and in some cases it even ceased entirely for some time, returning later. The contents of the stomach were first expelled, and then bilious matter. In five cases blood was present (including two cases of dark brown vomit), in one in clots. The ruptures were situated in the duodenum, jejunum, ileum (two cases), and "small intestine," showing that hæmatemesis does not indicate a rupture near the stomach. In two of these cases there was severe hemorrhage into the peritoneal cavity, and in one of them the stool was also bloody, complete rupture of the jejunum having occurred, and the blood probably finding its way into the peritoneal cavity, and into both ends of the bowel from an injured vessel on the edge of the wound. When life lasts for some time the vomiting may become fecal, but the study of this symptom must be deferred for the present.

Constipation will be seen to be the rule, but it must also be considered with the late symptoms, for the fact that no stool was passed in the first six hours would be of no clinical importance.

Urinary symptoms. These are important in excluding injury of the bladder and kidney. The character of the urine is unchanged in uncomplicated rupture of the intestine, yet there are two cases in which the urine was slightly bloody; the account of the autopsy not explaining this symptom, which must have been due to some slight contusion of the bladder or kidney. But the functions of the bladder are very frequently disturbed. Their condition is noted in 47 of the cases. Retention was present in 25 cases (one had stricture). Urination was difficult in 1 case, and normal in 17 cases—less than 50 per cent. Tenesmus was present in 4 cases.

The retention is, doubtless, to be looked upon as part of the condition of shock, but the tenesmus is not easy to explain. In one case there was severe hemorrhage into the belly, and this may have been the cause of the tenesmus. Suppression of urine occurred in one case—probably due to the severe shock present, from which the patient never reacted, although life lasted three or four days.

Pain. Pain in the abdomen is one of the first and most constant of the symptoms of rupture of the intestine, and it is usually severe. Pain was present in 104 cases—92 per cent.; and absent in 9 cases—8 per cent. It was severe in 74 cases—89 per cent.; and slight in 9 cases —11 per cent.

The pain may be burning or twisting, continuous or lacinating, but usually resembles the pain of colic. It may begin as a slight pain, and grow worse gradually or suddenly, or it may continue slight throughout. In some cases it ceased for a time, after longer or shorter duration. In nearly all the cases in which it was delayed, in common with the other symptoms, it appeared suddenly, and as the forerunner of speedy and fatal collapse. It is frequently so intense that morphine seems powerless to relieve it.

Pain was absent in the early stage in 9 cases, but developed later in 6 of these. One of the six was a man who was kicked by another upon an old hernia, and had no symptoms for six hours, and the delay was probably due to the fact that the extravasated fecal matter did not at once reach the general peritoneal cavity. There was no pain throughout the course of the case in two remarkable instances, which follow.

A boy,[1] six years of age, was crushed between a wagon and a fence. The only symptoms present were weakness, vomiting, and constipation. Death occurred in two and a half days. Autopsy showed a rupture extending entirely across the ileum, and peritonitis.

---

[1] Bentley: Pacific Medical and Surgical Journal, 1872, vi. p. 128.

A man,[1] thirty-six years old, suffering from general paralysis of the insane, fell while running away from an attendant, and the latter fell upon him. Vomiting and hiccough were present, but he felt no pain at any time, and lived for three days. Autopsy showed a rupture of the jejunum the size of a quill, with peritonitis.

Early collapse will frequently cause the pain to be apparently absent in the first hours after the injury; and opium used in treatment may conceal it at a later period, therefore care is necessary to exclude these sources of error.

Tenderness. We have notes as to the existence of tenderness in the early period in 62 cases. Tenderness was present in 55 cases—89 per cent.; and absent in 7 cases—11 per cent. It is described as great in 20 cases, and as slight in 4 cases. In one of the cases in which it was absent the statement is made that the pain was relieved by pressure. Of the seven cases in which tenderness was absent at first, its later appearance is noted in three, and one other, a child of four years, run over by a dray, was in collapse from the time of the accident until death, five hours later. In the remaining cases no mention is made of its later development, although life lasted one, two, and two and a half days. The following case is remarkable for the slight pain and tenderness:

A man,[2] thirty-two years old, fell twenty feet, from a tree, flat upon the ground, face downward, but arose and walked two hundred yards. In one hour there was pain in the abdomen, very little shock, and retention of urine. In three hours he vomited a little blood in clots, and the temperature rose to 100.6° F., but he remained cheerful. In twenty hours he could bear firm pressure on the belly, but there was tenderness in the iliac region. In twenty-four hours the belly was distended, he had pain for one hour, but it passed off. He remained comfortable and cheerful, and died quietly thirty-six hours after the accident. A rent in the ileum, which admitted three fingers, was discovered on autopsy.

Distention of the abdomen. This condition was present early in 33 cases, and later in 9—a total of 42. In 5 cases the belly is described as tense. Distention occurred at once in 2 cases; in 1 case it occurred "soon;" in another it immediately followed the reduction of a hernia upon which the blow had been received; and in 1 case it took place suddenly when the patient went to the closet to stool, some hours after the accident. Distention was absent at first in 16 cases, but it probably occurred later in most of those who live long enough to develop peritonitis.

Tension of the abdominal muscles. In 8 cases the abdomen is described as "tense," or "rigid," or "hard." In 8 the abdomen was "soft," or "natural," and in 8 others there seems to have been no contraction of the abdominal muscles. Therefore, the flat and tense belly, which is looked upon by some as symptomatic of perforation of the gut, is frequently absent, for we have seen that the belly is usually distended, and even when flat it is more frequently soft than hard.

---

[1] Yellowlees: Glasgow Medical Journal, 1875, vii. p. 415.

[2] MacLean: British Medical Journal, 1884, i. p. 267.

Tympanitic resonance. The percussion note was tympanitic in 25 cases in the early stage, and later in 6 others. In 4 cases this is the only description given of the belly, leaving us in doubt as to whether distention was present or not, but in only 1 case is it expressly stated that there was no distention. We may fairly assume that the percussion note was tympanitic in the cases in which distention was present. This would increase the total to 36 cases.

Dulness on percussion. In 6 cases an area of dulness was detected in the early stage, and in only 2 later.

Loss of liver dulness. The disappearance of the dulness on percussion over the site of the liver has long been considered a valuable sign in perforation of the intestine. Its uncertainty has also been frequently alluded to, especially its uncertainty as a negative sign. In only 4 of the cases collected has this point been noted. In 3 cases the liver dulness persisted, but in 1 of these the perforation was in the duodenum and extraperitoneal. In 1 case[1] the results of percussion were at first normal, but in twelve hours tympanites developed and the liver dulness disapppeared. We have then 2 cases in which it persisted to 1 in which it was lost. The latter case, indeed, is conclusive evidence that loss of liver dulness is not an immediate and necessary consequence of perforation of the bowel, else it would have occurred in that case at once, if at all.

It is evident that this sign depends upon certain conditions. There must be gas in the intestine, and it must escape before adhesions which could limit it have time to form; for although it is possible for gas to be generated in the peritoneal cavity this is a rare occurrence. The liver, too, must be free from adhesions which would retain it in its position. Even as a positive sign, loss of liver-dulness cannot be relied upon, unless it is certain that it had been present previously. The various conditions which might mislead in this respect are cirrhosis, backward dislocation of the liver, extreme tympanites, or an actual misplacement of the colon between the liver and the abdominal wall. The first condition could scarcely lead to error, for there would be the presence of other symptoms of the disease, even in the absence of any history. Dislocation of the liver is a very rare condition, and so is the misplacement of the colon, but if the latter ever occurs during life it would be likely to be found after such severe disturbance of the abdominal organs as must be occasioned by the great force which produces these injuries. Extreme tympanites is the condition which will most frequently trouble the surgeon in this respect, but if the liver has been forced above its normal position that fact can generally be determined by careful examination of the thorax. We may, therefore, conclude that total absence of liver-dulness is a tolerably certain proof of rupture of the intestine in these cases, but that its persistence is of no value as a sign that there is no perforation.[1]

---

[1] Bock: Deutsche Zeitschr. f. Chirurgie, xv. i. p. 11.

LATER SYMPTOMS AND COURSE.—The later symptoms are chiefly those of peritonitis, or septicæmia. We must give fuller consideration to the temperature, the constipation, and the fecal vomiting.

Temperature. The temperature is noted in 38 cases. In 7 cases there was no rise at any time, and in 4 of these the temperature was subnormal throughout. The average duration of life in these 8 cases was forty-four hours—not much less than what we shall find to be the average duration in all cases—forty-eight hours. Of the 31 cases with fever, the rise began during the first six hours in 7 cases, during the first twelve hours in 15 cases, and in all but 5 cases during the first twenty-four hours. One exceptional case had no fever until the fourth day. The highest temperature of the first six hours was 39° C. The average duration of life in the 30 cases with fever (one case being omitted, because laparotomy was performed) was sixty hours.

Constipation. In 22 cases there was no stool until death—an average of three and one-half days, and in 3 others the bowels were moved by purgatives. In 5 cases the bowels were moved, and in 1 of these there was diarrhœa, but the latter may have been accidental, and not caused by the injury. Blood was present in the stools in only 1 case, and in another the stools were black. This fact and the prevailing constipation show how valueless the well-known symptom of "bloody stools" will prove in diagnosis.

Fecal vomiting. Fecal vomiting occurred in 12 of the cases collected, being nearly 10 per cent. of the whole, and 17 per cent. of all the cases in which vomiting took place. It is, therefore, rather a common symptom. Fecal vomiting began as early as twelve hours after the accident in 1 case, and in 7 cases within the first thirty-six hours; in the other 5 cases it began on the third to the fifth day. In 2 cases there had been no previous vomiting, and in these the fecal vomiting began late. In 5 of the cases there was no stool, and in the rest the state of the bowels is not described, but as all but 1 of these died within thirty hours of the accident their testimony is not important. When the case is obscure, and fecal vomiting and constipation are both present, the likeness to intestinal obstruction may be very close—as it is in those cases of non-traumatic perforation-peritonitis in which laparotomy has been performed under a mistaken diagnosis. In one of the cases which began late, autopsy showed a complete obstruction of the gut at the point of rupture. In the other late cases it may have been caused by the mechanical obstruction caused by the forming adhesions. But in the early cases it is not so easy to explain, although a similar symptom is found in peritonitis due to perforating ulcer of the intestine. We might suppose a spasmodic or paralytic obstruction caused by the shock due to the injury, to the beginning peritonitis, or to the mere presence of fecal matter in the peritoneal cavity—but the whole matter is as yet too obscure to warrant even a supposition.

---

[1] For a full discussion of this question see Ebstein's paper on perforation-peritonitis, Zeitschr. f. klin. Med., 1885, ix. p. 209.

The peritonitis which the fecal vomiting accompanied was evidently septic or purulent, except in two cases which are described as "fibrinous," and, perhaps, here also, for it is not easy to exclude the septic element in such cases, yet in one of these there was no fecal extravasation to be detected.

The situation of the rupture in the bowel seems to exercise no influence upon the occurrence, or the time of appearance of this symptom, for it accompanies ruptures in all parts of the intestinal canal.

Fecal vomiting was usually a sign of impending dissolution, appearing within twelve hours of death in 5 cases, although 2 cases lived three days after it began. The prognosis is worst when it begins in the first twenty-four hours, for of 6 such cases 5 died within thirty hours after the accident. All the cases in which fecal vomiting occurred are divisible into two classes: 5 cases which died within thirty hours of the accident, and 7 cases which lived from three to eight days, and there is a remarkable absence of cases living what we shall find to be the most common length of life after the accident—forty-eight hours.

COURSE.—In studying the course of rupture in the intestine we must distinguish three sets of cases:

In the first set the shock caused by the accident never leaves the patient, may never diminish, but passes rapidly or slowly into a collapse which lasts until death. While this is a characteristic of the cases in which hemorrhage accompanies the injury, it is not confined to them, for we have seen that the accident itself, or fecal extravasation (occurring at the time, or subsequently) may produce a collapse which will prove fatal in a few hours. In this set of cases the duration of life is short, and may be even less than an hour, but occasionally it may be prolonged for days. When death is delayed, it is impossible to distinguish the boundary line dividing shock from septic poisoning, but the latter is the true cause of death if death does not occur soon after the accident, unless fecal extravasation has also been delayed. In the rare cases in which symptoms do not develop immediately, the clinical history begins with the first appearance of the symptoms, rather than with the accident. The still rarer cases in which there is no shock at any time must be classified with the following—omitting the first stage of shock and reaction.

The second set of cases includes those in which a frank peritonitis develops, with abdominal pain and tenderness, tympanites, and fever after the shock has passed off. These are the cases in which the diagnosis is easiest, but, unfortunately, they are not the most common.

The third set of cases is the most numerous. It comprises those in which, instead of an evident peritonitis after reaction from the shock has taken place, there are vague symptoms which keep the surgeon in expectation that peritonitis is about to develop, but nothing upon which he can found a positive diagnosis, for such light indications are common enough in the cases in which ultimate recovery has taken place. The patient lies in a state of apathy, seemingly satisfied with his condition, and thus misleads those about him; or he becomes gradually weaker, and because less able to complain, appears to be improving; or the symptoms of peritonitis develop by degrees, and so slowly that no one can say of any moment that it marked the beginning.

PROGNOSIS.—The prognosis in rupture of the intestine may be said to be absolutely bad, for even a suppositious case of recovery after this accident is so rare as to be a surgical curiosity. The following case[1] possesses great interest in this connection:

A blacksmith, forty-seven years of age, was struck in the right iliac region by the butt of a shotgun, which discharged unexpectedly while he was holding it. He immediately felt chilly and weak, and agonizing pain and vomiting soon set in. In forty-eight hours he was suffering from an acute attack of peritonitis, the belly somewhat swollen and hard. At the site of the injury there were tenderness and dulness on percussion; elsewhere tympanitic resonance. There was no external mark of injury. The stomach rejected everything; there had been no stool. He was very sick for five days, then improved. Ten days after the injury, getting out of bed, he became entangled in the blanket and fell upon the floor, face downward. Immediately he had frightful pain in the belly, vomiting began, collapse set in, and he died in fourteen hours. The autopsy showed the omentum adherent to the wall of the abdomen at the site of the blow, the intestines adherent and injected. Between the parietal peritoneum and the muscles was an extravasation of blood, the size of the palm of the hand. In a loop of intestine, lying half way between the umbilicus and the pubes, was a rent admitting four finger-tips. Fecal extravasation.

It is probable that in this case a small rupture took place at the time of the blow, with an extensive contusion of the gut. Adhesions closed in both, and the fall separated these and also tore open the weakened contused part.

Duration of life. An average computed on 112 cases gives the duration of life after the accident as forty-eight hours. That this average is not obtained by the union of extremes, but is a natural one, is shown by the fact that 8 cases died in the first twelve hours, 52 cases (46 per cent.) in the first twenty-four hours, and 82 cases (73 per cent.) in the first forty-eight hours. 4 cases lived eight days.

---

[1] Atlee: Med. and Surg. Reporter, lii. p. 6, 1885.

Evidently nothing is to be hoped from nature, and whatever improvement is to be made in the prognosis must be obtained by operative treatment. The history of what the latter has done up to the present time can be told in a few words. Omitting the cases of rupture of the intestine in a hernial sac, treated only by the ordinary operation for hernia, there have been recorded eight cases[1] of laparotomy with treatment of the ruptured intestine—six times by suture, twice by the clamp. Of these cases, six died soon after the operation; Bouilly's case lived ten days; Croft's four weeks.

In addition to these cases, laparotomy has been performed four times after contusion of the abdomen,[2] the lesions present being contusion of the colon and pancreas, rupture of the spleen (two cases), and rupture of the liver. These five cases terminated fatally, but the operation did no injury, and in some instances brought about a temporary improvement.

Two of the cases of laparotomy for rupture of the intestine can be claimed as recoveries, for Bouilly's case died of a fresh peritonitis set up by a rough examination of the artificial anus, when the original inflammation had entirely subsided; and Croft's case apparently died of inanition due to the artificial anus. In all the other cases the operation was undertaken so long after the injury that there was no hope for success. These two cases, however, with the case reported by Mikulicz,[3] prove that a peritonitis with fecal extravasation is amenable to surgical treatment. We may, then, confidently expect better things in the future, although the cases with very obscure symptoms, and those in which collapse sets in very early, must always remain beyond the reach of treatment.

DIAGNOSIS.—In attempting to make a diagnosis of the precise injury produced by a contusion of the abdomen, the cause of the injury and the exact situation of the blow should first be ascertained as accurately as possible. Certain causes, especially the kick of a horse or man, have been shown to be particularly liable to produce rupture of the intestine. The site of the blow, too, will often give a clew to the organ which has been injured—the liver, spleen, or bladder. In order to cause a rupture of the intestine, the blow must be so directed as to crush the gut between the contusing body and the spine or pelvis. The existence of hernia, the presence of bowel in the hernial sac, and the wearing of a truss at the time of the accident, all increase the liability to rupture of the intestine. A former attack of peritonitis, or the presence of hardened feces in the intestine would also naturally increase the danger.

---

[1] Dr. Gregory (operated 1876, St. Louis): Brit. Med. Journ., 1887, i. p. 1037. Demons: Rev. de Chir., May, 1885, p. 421. Girdlestone: Austral. Med. Journ., 1883, v. p. 100. Fitzgerald: Ibid., p. 264. Bouilly: Bull. Soc. de Chir., Paris, 1883, ix. p. 698. E. Owen: Lancet, 1885, ii. p. 663. Waggener: St. Louis Cour. of Med., 1886, xvi. p. 204. Croft: Brit. Med. Journ., 1887, i. p. 975.

[2] Chavasse: Bull. Soc. de Chir., Paris, 1885, xi. p. 123. Willett: St. Barth. Hosp. Rep., xix. p. 203. Mackellar: Brit. Med. Journ., 1887, i. p. 1037. Croft: Ibid., p. 976.

[3] Volkmann's Samml. klin. Vorträge, No. 262, p. 2315.

Contusion of the abdomen, with recovery. About four-fifths of all cases of contusion of the abdomen end in recovery. Thus Bryant (*Surgery,* fourth edition, p. 485) states that in seventy-one consecutive cases of contusion of the abdomen treated in Guy's Hospital, there was injury to some of the viscera in seventeen, there was peritonitis ending in recovery in ten, and in the remainder the symptoms were of short duration, and there was evidently no visceral injury. A number of cases of contusion of the abdomen ending in recovery have been collected and studied, with especial reference to the symptoms of the first six hours after the accident, in the same manner as the cases of rupture of the intestine. Almost all of these cases have been collected from literature, and therefore represent the severest forms of this injury.

Let us consider the symptoms of these thirty-three cases in the same order as has been followed for those of rupture of the intestine. In simple contusion of the abdomen the symptoms are at their worst at first, and in nearly all the cases a progressive improvement was observed when the change had once begun. But some of them developed peritonitis—fever, abdominal pain, and tenderness, tympanites, and vomiting being present as its symptoms. In a solitary case[1] the patient rallied from the shock which was present at first, and relapsed later. But this is so rare an occurrence that such a relapse is an almost certain sign of internal hemorrhage or injury to some of the viscera.

Shock was present in 28 cases, absent in only 1—a far larger percentage than in rupture of the intestine. The shock was severe in a remarkably large number—18 cases (66 per cent.); while it is noted as slight in only 4 cases. The shock was also very frequently of long duration—in 60 per cent. of the cases. In only 6 cases was it noted as short. In 6 cases it lasted several hours, and in 3 cases twelve, twenty-four, and sixty hours respectively.

Restlessness was present in only 3 cases, in 2 of which it was great, evidently due to internal hemorrhage.

Vomiting was present in 14 cases, 4 of which are said to have been severe, and 2 slight. It is noted as absent in 10 cases, but in 4 of these there was nausea. Vomiting appeared later in 5 cases in which it had not been present at first, usually as a symptom of peritonitis. Fecal vomiting was never noted, but in 2 cases the vomited matter is described as "altered blood" and "dark like feces." Vomiting, then, is less severe than in rupture of the intestine.

The stools contained blood only once. Constipation was the rule, but was probably due to opium in most cases. 7 cases had no stool for from two to four days; in 1 the bowels were regular; 2 had passages very soon after the accident, followed by constipation; and 1 had a free diarrhœa on the fifth day.

---

[1] Le Gros Clark: Diagnosis of Visceral Lesions. London, 1870, p. 266. (Supposed rupture of the liver.)

The urine was bloody in 3 cases; in 1 from contusion of the kidney, and in 1 perhaps from contusion of the bladder. Retention of urine was present in one-third of the cases in which the function of the bladder is noticed.

Pain was present in the abdomen in 29 cases, in 14 of which it was severe, and the pain may be as great as in any case of rupture of the intestine. Tenderness was present in 20 cases, in 8 of which it was described as great, and in 2 slight. There was no tenderness in 1 case, but it developed later also in this.

Physical signs. In 4 cases the abdominal muscles were tense. The abdomen was distended in 12 cases in the early stage, and in 2 others later, and distention is noted as absent in 1 case. This distention may occur immediately after the injury, proving that it must be a result of shock to the nervous centres, and very closely simulating rupture of the intestine, with escape of gas into the peritoneal cavity.

Tympanitic resonance was present early in 7 cases, and in 1 later. Dulness on percussion was present in 4 cases—in 1 at the site of the blow, and in 1 a movable dulness indicating fluid (blood) in the belly. The condition of the area of liver dulness is not given in a single case.

In fact, the symptoms are almost identical with those of rupture of the intestine, except in intensity and duration.

In a few cases of contusion of the abdomen it will be possible to decide what organs have been injured, but in by far the greater number of cases a diagnosis cannot be made. Thus local pain and tenderness would indicate rupture of the liver, spleen, or bladder; bloody urine, retention, tenesmus, and the facts learned by catheterization would allow of a diagnosis of rupture of the bladder; free blood or urine might give an area of dulness on percussion changing with position; signs of internal hemorrhage would make rupture of the liver or spleen probable, and next to these laceration of the mesentery; absence of these symptoms, and the presence of severe shock, great abdominal pain and tenderness, severe vomiting, and early development of peritonitis would favor rupture of the intestine. It will seldom be possible to decide, during the first six hours or more after the accident, whether the intestine has been ruptured or not. However slight the symptoms may be, it cannot be justifiable to declare that no visceral injury has resulted until several days, free from symptoms, have elapsed, for the symptoms may remain latent after injury to almost any of the abdominal organs, and such a course is not infrequent with rupture of the intestine and bladder. Even when the contusing force has been apparently trifling the greatest care should be exercised in giving a prognosis. If the visceral injury is merely a contusion of the intestine, the appearance of serious consequences may be delayed as much as a fortnight.[1]

TREATMENT.—Since the establishment of the rule that in penetrating gunshot wounds of the abdomen, immediate laparotomy is necessary, without waiting for symptoms of injury to the intestine, some have sought to extend the application of this principle to penetrating stab-wounds, and to all severe contusions of the belly. It is true that if rupture or severe contusion of the intestine has taken place, death is inevitable, unless laparotomy is performed at a very early period, just as this is true of gunshot wound of the bowel. But the intestine will almost certainly be wounded with penetrating gunshot wound of the belly, while in the severest forms of contusion, let the force be the most violent and the symptoms the most acute, there are, as we have already shown, many chances that the gut shall escape unhurt. Accordingly, the treatment of contusions of the abdomen must be wholly symptomatic—the surgeon having no right to assume that rupture of the intestine has taken place until symptoms appear which indicate its occurrence.

If it is apparent that hemorrhage is present, we should try to control it by pressure upon the abdomen, a firm pillow being bound upon it as tightly as can be endured, although one of the experiments on dogs showed that but little advantage is to be gained from any pressure which can be borne without anæsthesia. Morphine should also be given with care to quiet the circulation, and to relieve the intense pains in the belly and limbs, sometimes so excruciating that no amount of the drug consistent with safety can entirely prevent them, and stimulants must be withheld as far as possible. If the patient continue to sink, the surgeon should proceed at once to laparotomy, for many of these cases bleed to death from vessels which could be easily reached and ligated. To inject blood or salt solution into the veins of a patient while the blood is escaping elsewhere, is like pouring water into a vessel with a hole in the bottom, or as if one should treat a woman, dying of hemorrhage from placenta prævia, by transfusion without putting a tampon in the vagina.

After the vessels have been secured, stimulants and transfusion come into their proper place, and must be called upon at once to make up the loss of blood. Great collapse would contraindicate any operative interference, for laparotomy demands a certain amount of strength in the patient, and when the latter is very weak, it is already too late to save his life by operation.

If the case present no sign of hemorrhage, or if the hemorrhage soon cease, and there are no evident symptoms of rupture of the intestine, expectant treatment must be adopted; absolute rest in bed, very limited fluid diet, administered in small quantities, as little morphine as possible, in order not to obscure any symptoms about to develop, and continuous watching of the patient to detect the slightest change, for the only chance of success in these operations depends upon their performance at the earliest possible period, before septic poisoning and peritonitis can fully develop, and before the strength of the patient has been exhausted by pain and vomiting. Every rude method of examination, such as rough pressure on the abdomen to detect points of tenderness, or attempts to elicit "succussion sounds," are to be carefully avoided. Ordinary diet, large quantities of water, emetics, purgatives, and even enemata are to be absolutely prohibited. It is important to give no more morphine than is necessary to make the patient's sufferings endurable, seeking rather to relieve pain by hot applications to the abdomen, if no hemorrhage is present. Morphine probably acts in peritonitis only by relieving pain, and diminishing peristalsis. If we had the power of instantaneously and completely paralyzing the peristaltic movements of the gut immediately after rupture of the intestine had taken place, doubtless the best treatment would be to stop them at once and not allow them to recommence until time had been given for the formation of permanent adhesions. But we have no such power, for it is improbable that morphine can produce its effect upon peristalsis in time to prevent fecal extravasation, as the escape of feces probably occurs in most cases within a few minutes of the accident. The benefits to be gained by immediate and energetic use of opium in these cases do not counterbalance the greatly increased risk for the patient caused by the concealment of symptoms upon the early recognition of which his safety depends, if rupture of the intestine has taken place.

---

[1] L. Muguier: Thèse de Paris, 1883, reviewed in Centralbl. f. Chir., 1884, p. 181.

A typical case of rupture of the intestine would present shock, great abdominal pain and tenderness, severe vomiting, and perhaps a rise of temperature in the first few hours—the symptoms not improving with time. The physical signs, abdominal distention or retraction, loss of liver dulness, etc., might or might not be present. But the chief difference between these cases and those in which the intestine has escaped injury is the persistence of the symptoms, or their continued aggravation, and sufficient time must be allowed to elapse to determine this point—at least six hours. In a well-marked case with these symptoms, laparotomy is justifiable. If shock, pain, or tenderness be absent, the case is doubtful, and operation must be delayed until it becomes clearer. By far the largest number of cases will fall into this latter category. If there is a strong probability of rupture, an explorative operation is advisable; but the decision when operation is indicated, and how far it should be carried, must be left in each case to the judgment of the surgeon, as it is impossible to formulate rules for distinguishing cases which shade off into one another by such insensible gradations.

A few words are necessary in regard to the technique of these operations.

The incision must be a long one, for we have to deal with the normal abdomen; not distended, and with atrophied tissues, as in cases of abdominal tumor. The length of the incision for the exploration should be at least four inches. The length for the complete operation, when all the intestine is to be drawn out for examination, and the examination cannot be complete without this, should be at least eight inches, unless the abdominal walls are unusually relaxed. The centre of the incision should, as a rule, be at the umbilicus; but if it is evident that the injury was inflicted very high up, it may be advisable to have it an inch or so higher, to facilitate examination of the stomach. The incision should not be made lower, for the attachment of the mesentery may interfere with turning out the intestine, especially if the mesentery is short, or thickened with fat.

The peritoneum should be inspected before it is incised. If there be blood in the cavity it will probably make its presence known through the transparent membrane, but care must be taken not to confound an ecchymosis of the omentum lying under the incision with free blood, and the distinction will not always be easy. It will be possible, also, to ascertain the presence of gas, pus, or even congestion of the peritoneum, in some cases. The peritoneum having been inspected and incised, a sponge on a long forceps is to be passed into the pelvis, and examined on withdrawal for blood, pus, or feces. The same should be done for each lumbar region. It must be remembered that fecal odor is not an absolute proof of the presence of feces, for a fluid in the belly may contract this odor through mere contact with the intestine.

Parkes has already pointed out[1] that simply opening the abdomen will often cause the hemorrhage within it to cease, the contact of the air making the vessels contract, and the blood coagulate more firmly and rapidly. While this is true, especially when the bleeding proceeds from small vessels, the opening of the belly removes from its contents the pressure of the abdominal walls, and in some cases the hemorrhage will increase, instead of diminishing. Thus, in some of the experiments upon dogs, it was observed that the first serious symptoms of loss of blood appeared at the moment when the peritoneal cavity was opened, and the blood gushed from its interior. Dennis[2] suggests that a tourniquet without the pad, or an Esmarch elastic tube be placed around each thigh before the cavity is opened, and kept in place until the bleeding vessels have been secured, in order to save at least the blood contained in the lower extremities.

---

[1] The Medical News, May 17, 1884, p. 564.

[2] The Medical News, March 6, 1880, p. 254.

In performing laparotomy for internal hemorrhage, every step of the operation should be executed with the greatest rapidity. As soon as the belly has been opened, and a large amount of blood is seen welling up from the bottom, the operator should lift up the omentum, quickly pass his left hand underneath it, upward and backward, and make pressure upon the abdominal aorta and the root of the mesentery, at the highest point which can be reached. The hemorrhage will thus be temporarily controlled. With his other hand, and the aid of his chief assistant, the entire small intestine is to be quickly turned out, the mesentery being inspected as this is done, and any bleeding points seen secured at once with clamps; another assistant wrapping the intestines, as soon as brought out, in towels which have been soaking in a hot 1 to 4000 bichloride solution. The abdominal cavity is to be rapidly emptied of blood and clots, and all bleeding points seized. The pressure upon the aorta may then be gradually relaxed, the operator watching to see if all the injured vessels have been properly secured.

Up to this time stimulants should have been given with caution, so as not to interfere with nature's efforts to stop the hemorrhage, but now they must be pushed with energy, and if the patient is very weak, the salt solution must be prepared for transfusion. All the vessels having been tied with catgut, a more careful examination of the intestine is to be made, to discover any injuries to the gut, or any loops which have been deprived of their blood supply by injuries of the mesentery. Even in the first hurried examination it should be kept in mind that rupture of the gut may be present, and if any are found, the injured loops are to be wrapped in separate cloths, to avoid the danger of spreading the feces over the mass of intestines. In these cases it is probable that the patient will be too low to admit of so prolonged an operation as resection with suture, and it will be necessary to make an artificial anus.

If there were no injury of the gut, the cleansing of the peritoneal cavity, and the inspection and return of the intestine would require but a few minutes, and the abdominal wound having been partly closed by the introduction of a few deep sutures, a flat sponge being left inside as a further precaution, the operator would be at liberty to attend to the transfusion, completing the closure of the wound afterward. Even if the intestine were injured, all, except the injured part, could be returned after inspection and cleansing, the wound temporarily closed as just suggested, and the injured loops kept wrapped up in a warm cloth until the operator had made the transfusion. This early return of the uninjured parts was repeatedly found to have a remarkable effect in improving the pulse in the experiments on dogs, and will prove a very useful expedient when the shock is great; in fact, the intestines should always be returned as soon as the peritoneum has been cleansed.

But if the hemorrhage is not great, the operator should lift up the omentum, and carefully draw out the intestine, one loop at a time, wrapping the gut in towels as he lays it to one side, until the whole has been examined. It is impossible to make a thorough examination without removing the entire small intestine from the abdomen. Attention should first be given to those parts lying directly under the blow, for this is most frequently the situation of the injured loop. If any injuries are found, if they are extensive, and there is much fecal extravasation from the wound, the injured loops should be wrapped by themselves in a cloth, and kept separate from the rest until the examination has been completed. But if the injuries are of small extent, and there seems to be no fecal extravasation from the wounds, they should be closed at once according to the simple (and yet original) method employed by Bull[1] in the suture of gunshot wounds of the intestine under similar conditions.

The injured loop is carefully laid upon a large flat sponge, and steadied there by an assistant who holds the mesentery and avoids all pressure upon the gut itself, while the operator carefully picks up the wall of the intestine with mouse-tooth forceps and inserts the Lembert sutures, tying each one as soon as inserted. The needle preferred by Dr. Bull is the delicate, curved intestinal needle of Schramm. Fecal extravasation is avoided by the extremely careful handling of the gut, and the edges of the wound remain unsoiled, a great improvement on the ordinary method of removing the feces from the neighborhood of the wound by pressure upon the gut before the sutures are inserted, for it is almost impossible to do this without the escape of a small quantity, and the contamination of the edges of the wound.

All the intestines having been inspected, and all injuries treated at once or laid aside for later treatment, the peritoneal cavity is to be thoroughly cleansed with sponges. If there has been a rupture of the intestine, even if it is very small, and even if there has been no perceptible fecal extravasation, the whole cavity must be flushed with a 1 to 10,000 bichloride, or a 1 to 100 carbolic acid solution, at the temperature of the blood, or warmer. Still better would be plain water which had been kept boiling for at least an hour and then allowed to cool off, or cooled by the addition of cold water which had been previously boiled in the same way. A large quantity of water must be used, the cavity being filled and emptied several times. The warm water will be found to improve the condition of the patient, and, therefore, collapse is no contraindication to this flushing out of the belly.

The cavity having been cleaned, those portions of the intestine which are uninjured, or have been already treated, should also be thoroughly douched with the water, and, if much feces has escaped, should be well scrubbed with sponges. In cleaning the intestine, great care and many sponges will be necessary to prevent the fluid from running down the funnel formed by the mesentery, into the belly, which has just been cleaned. All these parts of the intestine can then be returned to the abdomen, only the loops still untreated being kept out. When excessive distention of the gut by gas interferes with its return to the belly, punctures may be made with a coarse aspirating needle, if care is taken to avoid escape of feces, and the punctures are closed by a couple of Lembert sutures to prevent subsequent leakage. If the large intestine be distended, a long flexible tube may be inserted into the rectum, and by manipulation through the walls of the gut it can be easily carried up beyond the sharp bends in the sigmoid flexure which usually impede its advance, and the entire colon thus emptied of gas.

---

[1] The author is indebted to Dr. Bull for permission to describe this method.

We have seen that there are three varieties of injury to the intestine to be expected, deprivation of blood-supply by injury of the mesentery, contusion or laceration of part of the coats of the gut, and rupture of all the coats for the whole or part of the circumference of the bowel. If the blood supply has been hopelessly destroyed in any part and gangrene is inevitable, that part must be removed. If the injury to the intestine is merely a laceration of part of its coat, or a contusion, suture will be necessary if the laceration involves more than the peritoneum, the injured spot being simply turned into the lumen of the gut and the folds thus made in the wall united over it by the Lembert suture. In these lacerations, the peritoneal, and even the deeper coats, are sometimes stripped off for a considerable extent, and resection of the injured part may be necessary.

The small ruptures will often allow of suture without resection, like bullet-wounds of the gut, the more so, that these ruptures do not often involve the mesenteric border, and hence do not interfere with the blood supply. Of intestinal resection and suture we need not speak further.

It is probable that the creation of an artificial anus will be the operation best suited to most cases of rupture of intestine in contusion of the abdomen. The collapse of the early stages, and the exhaustion later (when it has been impossible to make an early diagnosis) will in the great majority of cases prevent any attempt at such a prolonged operation as resection of the intestine with suture, and the latter should be reserved for the most favorable cases. It will be easy to restore the continuity of the gut at some later time when the patient has recovered from the accident, and the dread of having a permanent fecal fistula need not be allowed to weigh in the decision of the matter.

In making an artificial anus in these cases, both ends of the gut are to be occluded with ligatures or clamps, and as it will not be necessary to empty the gut at once, these may be left in place for twenty-four hours or longer, to allow adhesions to form and granulations to spring up, thus avoiding all danger of infection by escaping feces.

The creation of an artificial anus will greatly shorten the duration of a laparotomy for rupture of the intestine, and should be used in every case in which the patient's strength is doubtful. The operation admits of still greater abbreviation, if the patient is in a desperate condition, by securing the ends of the gut with a clamp or ligature, thoroughly cleaning the peritoneal cavity, passing the deep sutures for the abdominal wound further back from the edge than usual, in order to evert more peritoneum and make a broader peritoneal surface, and trusting to the pressure of these sutures, together with the aid of the clamp or ligature to hold the ends of the gut in place until the adhesions are firm. The entire operation performed in this way ought not to last more than half an hour, and would not be too much to attempt unless evidently fatal collapse had set in.

In performing laparotomy for supposed rupture of the intestine, the surgeon must be prepared to deal with any injury to the other abdominal organs. Rupture of the stomach would be treated on a similar plan to rupture of the gut. Rupture of the bladder would also be amenable to suture. In rupture of the liver, spleen, or kidney, it would be necessary first to control the hemorrhage—by ligature, deep sutures, the cautery, or pressure by a tampon of iodoform gauze. The spleen or kidney could be removed. It is certain that great triumphs await the surgery of the future in the treatment of these formidable injuries.

Undoubtedly in many cases of rupture of the intestine the patient will be too weak to permit of any operation, for it is certainly not justifiable to perform laparotomy when the patient is in collapse. This has already been done too often, as may be seen by the cases reported. Nothing is gained by such operations, and they bring discredit upon the surgeon and his art. If the patient is so feeble that it is impossible to bring about an improvement by the ordinary stimulants, he will certainly not survive laparotomy.

We may sum up the practical results of our inquiry in the following:

CONCLUSIONS.—1. The treatment of contusion of the abdomen should be purely expectant in the early stage, until symptoms of internal injury have appeared, or until the full extent of time in which they may be expected has passed. Explorative laparotomy at this time is inadmissible.

2. When symptoms of uncontrollable internal hemorrhage, or serious visceral injury appear, laparotomy is indicated; but, when the diagnosis is uncertain, the operation should always be begun as an exploration.

3. Great collapse is an absolute contraindication to all operative interference.

4. When rupture of the intestine is found, the best method of treatment is to secure the injured gut in the abdominal wound, and form an artificial anus. This can be easily relieved by a later operation, when the patient has recovered his strength.

ON HEPATIC CIRRHOSIS IN CHILDREN.[1]

By R. Palmer Howard, M.D., L.R.C.S. Ed., LL.D.,
PROFESSOR OF MEDICINE IN MCGILL UNIVERSITY, MONTREAL.

Having met with two cases of that rare affection in children, cirrhosis of the liver, I venture to make them the subject of a few observations; not that I hope to remove the obscurity which surrounds the subject, but rather to add to the few examples already recorded two more, in which neither the use of alcohol nor the virus of syphilis can be assigned as the cause of the hepatic cirrhosis.

The infrequency of cirrhosis of the liver in children may be substantiated by a few quotations. Thierfelder[2] speaks "of the absolute rarity of the affection as regards children." Henoch[3] admits that he never found the disease "fully developed in children." Dr. Charles West[4] states that "an experience of 70,000 cases of children's disease had yielded him but four examples of hepatic cirrhosis." The late lamented Flint, in a private letter to me respecting one of the cases about to be reported, dated December, 1884, remarks that "in so young a subject the disease is exceedingly rare." And Neureuter[5] estimates its ratio to other diseases admitted into the Franz Joseph Hospital for children at one-tenth of one per cent.

I will first relate the two cases that have been under my own care.

Case I.—Miss ——, aged nine years, was brought to me in November, 1878, on account of a few nævoid-looking groups of vessels on the right eyelid, which had formed, her mother thought, since a severe attack of pertussis experienced in the preceding July. On January 27, 1879, my services were again sought, because the child had been "poorly for some weeks." It was subsequently admitted that she had not been well for several months. She had been weak, fretful, nervous, and unable to perform her school-work, and her appetite had failed. Her leading symptoms at this first visit were a subicteroid tint of skin and conjunctiva, and enlarged liver, its lower margin extending an inch and a half below the ribs; the spleen also in the same condition, and its lower end perceptible two inches below the ribs. The upper abdominal zone was very perceptibly enlarged; indeed, her mother had for some time thought the child's waist increased in circumference. Pulse 114; temperature 103⅘° F.; tongue clean; urine of deep orange color; a loose cough, not explained by examination of chest, the organs in which were normal, so far as physical signs could be relied on. Expectoration scanty, semitransparent, viscid, and pink from the presence of a minute quantity of blood.

---

[1] Read at the meeting of the Association of American Physicians, Washington, June 2, 1887.

[2] Ziemssen's Cyclopedia, ix. p. 175.

[3] Lectures on Diseases of Children, 1882, p. 232.

[4] Diseases of Infancy and Childhood, 7th ed., p. 654.

[5] Oesterreichisches Jahr. für Paediatrik, 1877, viii.

Personal history. Is one of four children; all of whom are living and healthy, except a brother, who died of membranous laryngitis at five. All the four children have had symmetrical, handsome faces and figures, devoid of evidence of rickets, hereditary syphilis, or scrofula. The patient has always been healthy, and made good recoveries from measles, croup, chickenpox, and whooping-cough. She had escaped scarlatina.

Family history. Mother is remarkably healthy and well nourished. Mother's father died of valvular disease; mother's mother of disease of kidney; a maternal uncle of phthisis, and a maternal aunt of laryngeal diphtheria; another maternal aunt died of cerebral embolism from rheumatic valvular disease, a third from puerperal convulsions, and a fourth, three weeks after parturition, from some puerperal inflammation. Three maternal uncles and two aunts are alive, and enjoy good health.

The child's father, a vigorous, healthy man, has not had syphilis, and uses alcohol in moderation. The paternal grandfather had always been healthy, and died in advanced life; the paternal grandmother died when comparatively young, the cause of her death is not known; all the other members of father's immediate family, viz., a brother and two sisters, are living and healthy.

It would occupy too much time to report the daily notes, and the leading facts must suffice.

A febrile temperature prevailed throughout the four months that the child lived after coming under observation. During the first four days of February it was 104°, and for the rest of the month it ranged between 101° and 100°. The average daily temperature for the first fourteen days of March was 100.7°, and for the remainder of the month about 99.4°. For the first week of April the temperature ranged between 101° and 100.5°, for the second week between 100° and 99°, and for the rest of the month between 100° and 98⅘°, although it was but three times below 99°. For the first half of May it ranged between 100° and 101°; during the last ten days of the patient's life the temperature was not recorded.

Epistaxis was frequently present throughout the illness, in moderate amount, yet sufficient to soil three handkerchiefs a day. It had occurred, however, very often since the attack of whooping-cough in July.

Hemorrhage from the kidneys was also a persistent symptom after its first appearance on February 25th. The urine was rarely free from blood after that date, but the removal of the pressure of the ascitic fluid by tapping was followed by a temporary sensible reduction in the proportion of blood contained in the urine.

In the early part of February pain of the character of "bellyache" was experienced in the umbilical region for one day, but it was unaccompanied by tenderness on pressure. Pain in the splenic region was complained of for three days before the first tapping, which was performed on April 7th. It did not recur in that region for three weeks, at which time the belly was rapidly refilling. But the night succeeding the first tapping, pain occurred in the right side of abdomen, and persisted for the four succeeding days; yet it was unaccompanied by tenderness, or a higher temperature than had immediately preceded the paracentesis, and the ascitic fluid was found to be transparent even after the third tapping, which became necessary a fortnight after the second.

From these facts it may be concluded that the turbid serum and recent